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ABSTRACT

This study investigated the effects of self-generated questions and external questions on thinking processes. Thirty-three college students acted as investigators in a computer simulation of a Congressional investigation into the Pearl Harbor attack. The simulation--known as "The Attack on Pearl Harbor: Cloud of Mystery?"--presented the background of the attack and information based on a 1946 Congressional investigation. At the end of the program, subjects were asked to draw conclusions about who should be blamed for the lack of preparedness on the part of the United States military. Conclusions were scored based on the thinking processes involved, and scores were used as a dependent variable. Subjects received the program under three conditions of questioning: (1) externally-generated high order questions (questions generated by the experimenter that require learners to respond by applying, analyzing, synthesizing, and evaluating the previously presented information); (2) externally-generated low order questions (questions generated by the experimenter that require learners to respond by recalling the information previously presented); and (3) self-generated questions (questions generated by learners in response to the experimenter's prompts). Results indicate that the question conditions were unrelated to the quality of the final explanations. However, notetaking was related to the quality of the final explanations. The non-significant findings for question conditions were interpreted as indicating that questions may elicit performance without the subjects actually interrogating the material. Three data tables are provided. (TJH)

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THE EFFECTS OF QUESTIONING ON THINKING PROCESSES

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American Educational Research Association

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ABSTRACT

This study investigated the effects of self-generated questions and external questions on thinking processes. Thirty-three college students assumed the role of investigators in a computer simulation of a congressional investigation on the Pearl Harbor attack. Subjects received the program under three conditions of questioning: (1). external higher order questions, (2). external lower order questions, and (3). self-generated questions. The results revealed that question conditions were unrelated to the quality of the final explanations. Note-taking was related to the quality of the final explanations. The non-significant findings for question conditions were interpreted as indicating that questions may elicit performance without the subjects actually interrogating the material.

INTRODUCTION

"The most pronounced emphasis in the educational literature is upon asking questions of a higher-cognitive order than fact, memory, and knowledge. Higher types presumably elicit more complex thought-processes and consequently longer responses" (Dillon, 1982, p. 143). However, Sternberg (1987) pointed out that the asking of questions is as important as the answering of questions in studying intellectual performance.

The topics of higher versus lower order questions, and external versus self-generated questions have been researched almost exclusively within a reading comprehension or memory framework. It is rare to find studies of the impact of various questioning techniques on cognitive processes or information processing activities. In this study we examine whether self-questioning or external questioning leads to more complex (thoughtful, deeper) processing and better information utilization?

RELATED RESEARCH

Ernst Rothkopf's (1966) pioneering study on questioning set the stage for much later research on questioning. Since then research has been conducted extensively in the areas of the presence of questions in texts, the position of questions, the level of questions, and the format of questions. The studies in these areas generally yielded mixed findings.

The self-questioning technique has been found in past studies to have positive and significant effect over other techniques such as re-reading, no questioning, and answering questions (Andre & Anderson, 1978; Frase, & Schwartz, 1975; Blaha, 1979; Cohen, 1983; Davey & McBride, 1986). Self-questioning is reported to be more effective for lower than for higher ability students (Andre & Anderson, 1978-1979), yet it is also found that the self-questioning technique works only for those who are above average in ability (MacDonald, 1986). Still, some researchers found that there is no significant effect of self-questioning (Owens, 1976; Pederson, 1976; Martin, 1985). Prosser (1974, 1978) obtained mixed results in a study of self-questioning on reading comprehension.

Wong (1985) reviewed twenty seven studies on self-questioning instruction on reading comprehension, and tallied the results. Fourteen studies (52%) found that self-questioning instruction succeeded in increasing students' prose processing, nine studies (33%) showed no effect, and five studies displayed varying effects.

In summary, the results of the studies on self-questioning are inconsistent and mixed. As noted earlier, most of the studies have focused on the role of questioning on reading comprehension or memory.

The study of self-questioning offers one way of tapping some of the cognitive processes that occur in the reader during reading comprehension (Wong, 1985). The notion that students' questions provide an index of cognitive processes is suggested by the Olson, Duffy, and Vincent's (1982) study which was cited by Wong (1985). Olson et al.'s (1982) study suggested that self-questioning "taps the kind of informational

needs a reader encounters while proceeding through a text", and they also suggested that "ea ch question may reflect a mental operation that the reader must carry out for the particular sentence as part of understanding it" (Wong, 1985). Hence, the self-questioning may "serve as indices of the various kinds of cognitive processing that occur in reading comprehension" (Wong, 1985).

The relationship between self-questioning and cognitive process is also supported by Andre and Anderson's (1978-79) research which has shown a significantly improved performance on the test of comprehension associated with self-questioning. Andre et al. also suggested that the improved performance could be attributed to 'levels-of-processing' notion. If the questions were formed by cognitive analysis during the initial information processing, then information will more likely be processed at deep levels (Andre, 1987).

THE PROBLEM

This study was conducted to examine the comparative effects of different types of questions (self-generated questions, external high questions, and external low questions) on thinking processes. Some subjects had opportunities to ask questions, and others answered higher order or low order questions already inserted in the readings. Thinking was evaluated by the quality of processes exhibited in formulating interpretations and explanations at the end of the readings.

METHOD AND PROCEDURES

Thirty three students from history classes at Purdue University participated in this study. A computer simulation, "The Attack on Pearl Harbor - Cloud of Mystery?" presented the background of the Pearl Harbor attack and information based on a congressional investigation in 1946. At the end of the information presentation, the subjects were asked to draw conclusions about who should be blamed for the total surprise of the Pearl Harbor attack. These conclusions were scored based on the thinking processes involved, and these scores were used as a dependent variable.

The simulation was administered under three treatment conditions:

1. Externally-generated high order questions - questions generated by the experimenter which require learners to respond by applying, analyzing, synthesizing, and evaluating the previously presented information.

2. Externally-generated low order questions - questions generated by the experimenter which require learners to respond by recalling the information previously presented.

3. Self-generated questions - questions generated by learners in response to the experimenter's prompts.

These categories of questions represent the major independent variables in this study.

SCORING PROCEDURES

The scoring rationale focused on the level of thinking the subjects used to reach and support their conclusion. The subjects' conclusions were scored using the following scoring rationale on a holistic basis and assigned a number from 0 to 4.

O. Level Zero:
The response fails to show any causal elements. The responses reveal no attempts to make

any causal connection within the material.

I. Level One:

At this level of thinking, subjects perceived only a few significant features in the information and draw a relatively obvious conclusion. Subjects may list two or three factors which support their position. But much of the information is ignored. There is no attempts to recognize or adjudicate different points of view. The presented information is simply repeated rather than used to establish connections among parts of the information.

II. Level Two

At this level, subjects recognize or identify conflicts or incongruity among several pieces of information or between two points of view. The conflicts can lie within the presented information or the inferences drawn from the reading. The major characteristic of this level is the emphasis on conflicting interpretations among pieces of information. An alternate point of view can be found in this level. As opposing to level three, the conflicts refer to only a single aspect of the Pearl Harbor situation

III. Level Three:

Establishing connections, among the supporting information and between the explanatory position is the major emphasis of this level. Connections refer to the links (relationships) among the information from the reading or from an external source introduced by the subject. Several aspects or alternative viewpoints of the Pearl Harbor situation are considered and the response has a definite explanatory tone. The explanation, however, does not assess the situation within a global framework.

VI. Level Four:

This level is marked by an attempt to formulate an integrative framework. Subjects may develop a hypothesis or theory about the attack. Events are organized into a coherent picture consistent with the hypothesis or the theory. The major characteristic of this level is a more global assessment which includes several aspects of the situation. Alternative frameworks may also be proposed.

In all cases, the subject was assigned the score which showed highest level of thinking reached.

RELIABILITY AND VALIDITY OF THE SCORING PROCEDURE

The data to support the reliability and validity of the scoring procedure were collected during the experiment. The subjects' final conclusions were scored independently by two raters using the scoring rationale. The inter-rater reliability was .87.

The data to support the validity of the scoring procedure was obtained from a history professor who independently graded the responses of his twenty-one students. He used his own three-point scale based on "carefully reasoned answers" to indicate the overall quality of the responses. The correlation between the professor's independent ratings and our scoring was significantly correlated: final conclusions, .49 ($p < .01$). This correlation provided strong support for the validity of the scoring rationale.

ANALYSES AND RESULTS

To determine the impact of question types on subjects' responses, an analysis of variance (ANOVA) had been planned. From a preliminary examination of the data, however, note-taking might have an influence on the subjects' responses. The impact of note-taking, therefore, was examined first to determine whether the ANOVA or analysis of covariance (ANCOVA) should be performed to examine the the effects of question types.

THE IMPACT OF NOTE-TAKING

A correlation was computed for note-taking and the final conclusion, and the correlation coefficient was

.40. It means that the subjects who took notes during reading tended to produce better final conclusions for the Pearl Harbor exercise. Additionally, a two-tailed t-test was conducted to test differences between the groups with note-taking (n = 14) and without (n = 19). The results, presented in Table 1, indicate that the groups, which took notes during reading produced significantly better final con clusions.

THE IMPACT OF QUESTION TYPES

Since note-taking was significantly related to the quality of final conclusions, the ANCOVA was used to test the effects of question types on the quality of final conclusions with note-taking as the covariant. The results of ANCOVA shown in Tables 2 indicated that the model did not reach significance at the .05 level on the quality of final conclusions ($F = 2.50$, $p = .079$) with the influence of note-taking removed.

The means for final conclusions adjusted by removing the effects of note-taking are presented in Table 3. It may be noted that the results consistently indicated that the external-high question group performed slightly better than both the external-low question group and the self-questioning group. However, these differences were not statistically significant.

The analyses of the data in this study did not support the contention that subjects in different question groups (External-high, External-low, & Self-generated) would formulate different levels of explanation of the Pearl Harbor Attack.

Did quality of answers to the questions influence the quality of final conclusions?

Several supplemental analyses were conducted to determine the relationship between the answers to the inserted questions and the quality of final conclusions. The levels of complexity of the answers to the externally generated questions, were scored holistically ranging from simple (1 point) to complex (4 points). Then, the subjects was divided at the median into two groups (low and high), and the differences in quality of the final conclusion was evaluated by a t-test. The results for external-low ques tion group, external-high question group, and self-questioning group revealed that subjects who performed better in questioning activities did not perform significantly better on final conclusions than those who had lower scores in questioning activities.

DISCUSSION AND CONCLUSIONS

This study makes substantive, theoretical and methodological contributions to the study of thinking processes. While the efficacy of note taking in memory and comprehension has been generally established, there is little evidence that these findings have been extended into the area of higher cognitive processes (Kiewra, 1988; Hartley & Davies, 1978). We found clear evidence that students who elected to take notes produced better (more thoughtful, complex, and complete) explanations than students who elec ted not to take notes. Whether note taking plays an instrumental role in thinking processes or is an index of more general characteristics (task involvement, learning styles, study habits, etc) remains an open question.

We found no evidence to support the expectation that higher order questions inserted in the material would produce better explanations than lower order questions. This finding supports Dillon's (1982) contention that the nature of questions asked in instructional transactions may reveal a good deal about the cognitive processes of the questioner, but very little about the cognitive processes of the respondent. The "higher order" questions of the teacher or the experimenter do not necessarily become the " higher order" question of the learner. The effect of higher order questions on complex thought-processes remains undemonstrated, and may make little difference compared with fact question (Dillon, 1982; Winne, 1979; Hamilton, 1985).

Even when we examined the quality of subjects' responses to the inserted questions, we found that high

quality responses to specific questions did not carry forward to high quality explanations of the total situation. This suggests that subjects may have been responding more to the isolated demands of the experimental program than to their own needs to integrate materials over the whole exercise.

Even more surprising was the finding that the quality of explanations was unrelated to opportunities for self-generated questions. Students who generated their own questions produced no better explanations than students who found question already inserted in the material. Again, when subjects generated high level questions in response to prompts, these questions did not foreshadow better explanations at the end of the exercise. What do these findings mean? As Dillon's (1982) article reminds us, questions often create a demand that students respond, but they do not necessarily stimulate information processing. A question, according to Dillon, expresses perplexity and requests information. Perplexity and the need for information are psychological phenomenon, not behavior. Questions, on the other hand, are behavior which may or may not represent the underlying psychological reality. We are suggesting that in our study, and perhaps in many similar studies, the prompts to generate questions produced overt behavior which was not systematically related to internal information processing activities. This interpretation is bolstered by our finding that internally generated questions produced on demand did not lead to better explanations of the total complex situation, even when the questions were judged to be "higher order" questions. This observation has relevance to emerging theories about the role of questioning in learning and using information. Investigators need ways of demonstrating that experimental manipulations (pre, post, inserted, external, internal, etc questions) actually trigger the psychological states of perplexity and need for information which are assumed to be activated.

In retrospect, it seems possible that the "self-questioning" condition may not have elicited genuine information seeking. That is, subjects may have produced questions in compliance with the demands of the experimenters' prompts rather than in response to their own emerging curiosity. Neither can we be sure that subjects in the external questioning conditions did not respond to private and unarticulated questions. These considerations point to an important aspect of the experimental methodology. Further studies might let subjects interact with the materials in any way they choose followed by an interview to determine the nature of cognitive processes used. The interviewer would be particularly sensitive to the extent to which subjects did or did not spontaneously ask questions of the materials as they processed the information.

One of the contributions of this study may be the procedure for assessing some aspects of thinking processes. This procedure includes a computer-based program which makes data collection easy and efficient. The scoring rationale for the Pearl Harbor exercise generated reliable scores which were significantly correlated with an independent rater's assessment of subjects' responses. These evidences of validity and reliability, coupled with the high level of subjects' acceptability, makes the Pearl Harbor exercise an attractive procedure for measuring cognitive processes. Other investigators will no doubt further refine the scoring rationale and seek alternative experimental design within which to collect data. We view the Pearl Harbor exercise as a procedure of great flexibility and high potential for application to a wide range of problems within the area of cognitive sciences.

Table 1. t-tests between the groups with note-taking and without.

	Note-taking	No. of cases	Mean	S.D.	T value	D.F.	2-tail prob.
Final	N	19	1.84	0.83	-2.46	31	0.020
	Y	14	2.57	0.85			

Table 2. Analysis of covariance for the final conclusion by general linear models procedures (N = 33).

Source	D.F.	Sum of Squares (S.S.)	Mean Square (M.S.)	F value	PR > F
Model	3	5.393	1.798	2.500	0.079
Error	29	20.850	0.719		
Total	32	26.242			

Source	D.F.	Sum of Squares (Type III S.S.)	F value	PR > F
Question type	2	1.105	0.770	0.473
Note-taking	1	4.605	6.400	0.017

Table 3. Adjusted means after removing the effects of note-taking for final conclusions

Dep. Var.	Quest. Type	Adjusted means	Standard error
Final	Ext. Low	2.05	.26
Conclusion	Ext. High	2.41	.26
Self-Quest.	2.00	.26	

Footnote 1: The reading level of the materials was evaluated by a software program, the Readability Calculations (Micro Power & Light Co., 1982). The Powers Reading Ease formula showed a grade level of 7.4, and the Holmoquist formula showed a grade level of 8.3. The reading was presented using the IBM personal system 2/model30 computers with color monitors. These computers were used on a network system which had a 70 MB hard disk to store the subjects' responses.

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